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Particle kinetic effect leading to collisionless magnetic reconnection in the presence of an external driving source is investigated by means of a two-and-a-half dimensional particle simulation [1]. Magnetic reconnection develops in two steps due to two kinds of particle kinetic effect, i.e., ion kinetic effect which is responsible for the slow reconnection in early phase, and electron kinetic effect which is responsible for the fast reconnection in late phase. The growth rate of reconnection electric field for the slow phase  $\gamma_1$  and that for the fast phase  $\gamma_2$  is shown in Fig. 1 as a function of a longitudinal magnetic field  $B_{z0}$  where the input rate of in-plane magnetic flux at an input boundary is drawn by dotted curves for comparison. One can find that the growth rate decreases in proportion to the flux input rate as a longitudinal magnetic field becomes stronger. This result implies that the growth of reconnection electric field is controlled by an external condition such as a flux input rate into the system even if magnetic reconnection would be triggered by mechanism associated with electron kinetic effect in the central region of current layer.

Each kinetic effect contains two specified mechanism leading to magnetic reconnection in a collisionless plasma, i.e., particle inertia effect which becomes significant in a spatial scale comparable to collisionless skin depth, and particle thermal effect which becomes effective in an excursion distance of particle meandering motion. Figure 2 illustrates the dependence of four spatial scales in the fast reconnection phase on a longitudinal field. For a weak field of  $B_{z0} < 1.5B_0$  where the excursion distance of electron meandering motion  $l_{me}$  is longer than  $c/\omega_{pe}$ , the width of current layer  $d_{Bx}$  decreases as  $B_{z0}$  increases, while keeping the relation  $d_{Bx} \approx l_{me}$ . When  $l_{me} < c/\omega_{pe}$  or  $B_{z0} > 1.5B_0$ , the width is almost independent of  $B_{z0}$  and the relation

$d_{Bx} \approx c/\omega_{pe}$  holds. This means that collisionless driven reconnection proceeds keeping the width of current layer nearly equal to the electron skin depth for a strong field. It is concluded that the triggering mechanism for collisionless driven reconnection in the fast reconnection phase changes from the electron thermal effect to the electron inertia effect in accordance with the increase of a longitudinal magnetic field.

#### References

- 1) R. Horiuchi and T. Sato, ICPP94 **3**, 169(1994); Phys. Plasmas **1**, 3587(1994); submitted to Phys. Plasmas.

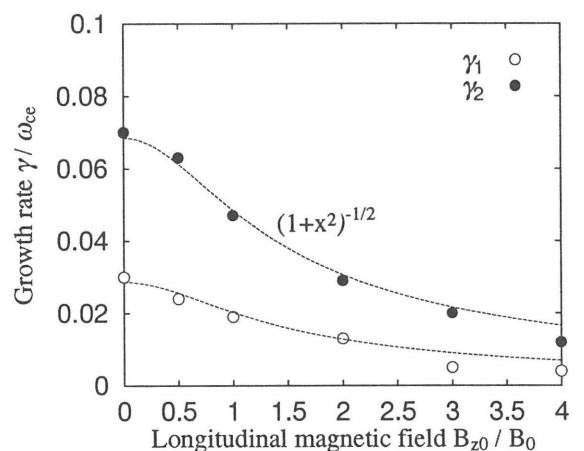


Figure 1: Dependence of two growth rates on a longitudinal field

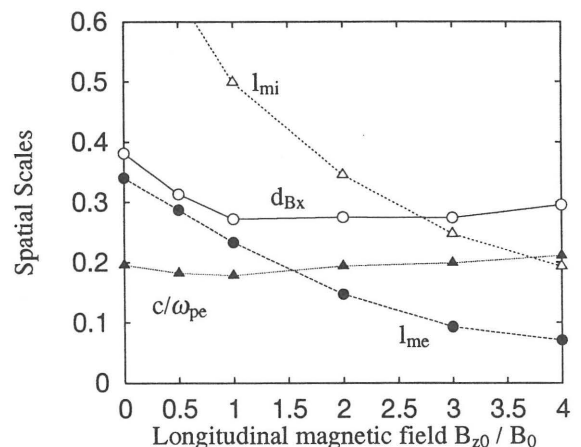


Figure 2: Dependence of four spatial scales on a longitudinal field